Chapter 5 - On-Site Stormwater Management

Note: Figures 5.1 through 5.5 are courtesy of King County
~~Figures 5.6 and 5.7 from Ecology 1992 Manual~~
~~Figures 5.8 through 5.14 are courtesy of Washington Concrete and Aggregate Association~~

5.1 Purpose

This Chapter presents the methods for analysis and design of on-site stormwater management Best Management Practices (BMPs). Many of these BMPs, although being used elsewhere, are new locally. Efforts are underway to further develop these "low impact development" concepts in Western Washington. Ecology will update these BMPs ~~when~~ as local standards are established.

5.2 Application

The On-Site Stormwater Management BMPs presented in this Chapter have application to treatment situations specified in Volume V, Chapter 3.

On-site BMPs focus on minimization of impervious surface area, the use of infiltration, and dispersion through on-site vegetation for stormwater runoff flow control and treatment.

Most of the BMPs serve to control runoff flow rate as well as to provide runoff treatment. Non-pollution generating surfaces, such as rooftops and patios, may also use the infiltration BMPs contained in Volume 3, Section 3.1, which provide flow control only. Pollution-generating surfaces, such as driveways, small parking lots, and landscaping, must use on-site BMPs to provide some water quality treatment.

5.3 Best Management Practices for On-Site Stormwater Management

~~Included are t~~The following ~~specific~~ On-Site Stormwater Management BMPs are included~~discussed~~ in this Chapter:

Section 5.3.1 - Dispersion and Soil Quality BMPs (Required for Manual Equivalency)

BMP T5.10 Downspout Dispersion
BMP T5.11 Concentrated Flow Dispersion
BMP T5.12 Sheet Flow Dispersion
BMP T5.13 Post-Construction Soil Quality and Depth

Section 5.3.2 - Site Design BMPs

BMP T5.20 Preserving Natural Vegetation
BMP T5.21 Better Site Design

BMP T5.30 Full Dispersion

Note: Ecology proposes to delete the following sections. The reader is directed to Low Impact Development Technical Guidance Manual for Puget Sound, authored by the Washington State University Cooperative Extension and published by the Puget Sound Water Quality Action Team. The document is available at the following websites:

http://www.psat.wa.gov/Publications/Publications.htm

http://www.pierce.wsu.edu

The document provides updated guidance concerning these BMP's. Also, the reader is directed to Appendix C in Volume III of this manual where directions are given concerning flow reduction credits for using these BMP's.

~~**Section 5.3.3 – Other Practices**~~

~~BMP T5.30 Full Dispersion~~
~~BMP T5.31 Vegetated Rooftops~~
~~BMP T5.32 Cisterns~~
~~BMP T5.33 Concave Vegetated Surface~~
~~BMP T5.34 Multiple Small Basins~~
~~BMP T5.35 Engineered Soil/Landscape Systems~~
~~BMP T5.36 Soil Compaction Protection and Mitigation~~

~~**Section 5.3.4 - Permeable/Porous Pavements**~~

~~BMP T5.40 Porous Pavement~~
~~BMP T5.41 Porous Pavers~~
~~BMP T5.42 Permeable Interlocking Concrete Pavement~~

Projects shall employ these BMPs to infiltrate, disperse, and retain stormwater runoff on site to the maximum extent practicable without causing flooding or erosion impacts. Sites that can fully infiltrate (see Volume III, Chapter 3) or fully disperse (see BMP T5.30) are not required to provide runoff treatment or flow control facilities. Full dispersion credit is limited to sites with a maximum of 10% effective impervious area that is dispersed through 65% of the site maintained in natural vegetation.

Impervious surfaces that are not fully dispersed should be partially dispersed to the maximum extent practicable and then hydrologically modeled. If the model predicts that there will be a 0.1 cfs or greater increase in the 100-year return frequency flow, or if certain thresholds of impervious surfaces or converted pervious surfaces are exceeded within a threshold discharge area (see Volume 1, Table 2.2), then a flow control

facility is required. Also, a treatment facility is required if the thresholds in Table 2.1 of Volume 1 are exceeded. ~~Residential roofs that are dispersed through at least 50 feet of native vegetation may be modeled as grass. Other impervious surfaces that are partially dispersed will not be given flow credit. Modular grid pavements will be allowed a flow credit. Porous concrete and asphalt will not be allowed a flow credit at this time due to the uncertainty of long-term viability.~~

5.3.1 Dispersion and Soil Quality BMPs (Required for Manual Equivalency)

The following BMPs pertain to dispersion and soil quality applications.

BMP T5.10 Downspout Dispersion

Purpose and Definition

Downspout dispersion BMPs are splashblocks or gravel-filled trenches that serve to spread roof runoff over vegetated pervious areas. Dispersion attenuates peak flows by slowing entry of the runoff into the conveyance system, allows for some infiltration, and provides some water quality benefits.

Applications and Limitations

- Downspout dispersion is required on all subdivision single family lots which meet one of the following criteria:
  1. Lots greater than or equal to 22,000 square feet where downspout infiltration is not being provided according to the requirements in Volume III, Chapter 3.
  2. Lots smaller than 22,000 square feet where soils are not suitable for downspout infiltration as determined in Volume III, Chapter 3 and where the design criteria below can be met.
- All other projects required to apply Roof Downspout BMPs must provide downspout dispersion if downspout infiltration is not feasible or applicable as determined in Volume III, Chapter 3, and if the design criteria below can be met.

Flow Credit for Roof Downspout Dispersion

If roof runoff is dispersed according to the requirements of this section on single-family lots greater than 22,000 square feet, and the *vegetative flow*path* is 50 feet or larger through undisturbed native landscape or lawn/landscape area that meets BMP T5.13, the designer may click on the "Credits" button in the WWHM and enter the percent of roof area that is being dispersed.

General Design Guidelines

- Dispersion trenches designed as shown in the Figures 5.1 and 5.2 shall be used for all downspout dispersion applications except where splashblocks are allowed below. See Figure 5.3 for a typical splashblock.
- Splashblocks may be used for downspouts discharging to a vegetated flowpath at least 50 feet in length as measured from the downspout to the downstream property line, structure, sensitive steep slope, stream, wetland, or other impervious surface. Sensitive area buffers may

* *Vegetative flow path* ~~path~~ is measured from the downspout or dispersion system discharge point to the downstream property line, stream, wetland, or other impervious surface.

BMP T5.11 Concentrated Flow Dispersion

Purpose and Definition

Dispersion of concentrated flows from driveways or other pavement through a vegetated pervious area attenuates peak flows by slowing entry of the runoff into the conveyance system, allows for some infiltration, and provides some water quality benefits. See Figure 5.4.

Applications and Limitations

- Any situation where concentrated flow can be dispersed through vegetation.
- Dispersion for driveways will generally only be effective for single-family residences on large lots and in rural short plats. Lots proposed by short plats in urban areas will generally be too small to provide effective dispersion of driveway runoff.
- Figure 5.4 shows two possible ways of spreading flows from steep driveways.

Design Guidelines

- A vegetated flowpath of at least 50 feet should be maintained between the discharge point and any property line, structure, steep slope, stream, lake, wetland, lake, or other impervious surface.
- A maximum of 700 square feet of impervious area may drain to each dispersion BMP.
- A pad of crushed rock (2 feet wide by 3 feet long by 6 inches deep) shall be placed at each discharge point.
- No erosion or flooding of downstream properties may result.
- Runoff discharged towards landslide hazard areas must be evaluated by a geotechnical engineer or qualified geologist. The discharge point shall not be placed on or above slopes greater than 20% or above erosion hazard areas without evaluation by a geotechnical engineer or qualified geologist and approval by the Local Plan Approval Authority.
- For sites with septic systems, the discharge point should be downgradient of the drainfield primary and reserve areas. This requirement may be waived by the Local Plan Approval Authority if site topography clearly prohibits flows from intersecting the drainfield.

Flow Credits

- Where BMP T5.11 is used to disperse runoff into an undisturbed native landscape area or an area that meets BMP T5.13, and the vegetated flow path is at least 50 feet, the impervious area may be

modeled as landscaped area. This is done in the WWHM by entering the impervious area into the" landscaped area" field.

BMP T5.12 Sheet Flow Dispersion

Purpose and Definition

Sheet flow dispersion is the simplest method of runoff control. This BMP can be used for any impervious or pervious surface that is graded so as to avoid concentrating flows. Because flows are already dispersed as they leave the surface, they need only traverse a narrow band of adjacent vegetation for effective attenuation and treatment.

Applications and Limitations

Flat or moderately sloping (<15% slope) impervious surfaces such as driveways, sport courts, patios, and roofs without gutters; sloping cleared areas that are comprised of bare soil, non-native landscaping, lawn, and/or pasture; or any situation where concentration of flows can be avoided.

Design Guidelines

- See Figure 5.5 for details for driveways.
- A 2-foot-wide transition zone to discourage channeling should be provided between the edge of the driveway pavement and the downslope vegetation, or under building eaves. This may be an extension of subgrade material (crushed rock), modular pavement, drain rock, or other material acceptable to the Local Plan Approval Authority.
- A vegetated buffer width of 10 feet of vegetation must be provided for up to 20 feet of width of paved or impervious surface. An additional 5 feet of width must be added for each addition 20 feet of width or fraction thereof.
- A vegetated buffer width of 25 feet of vegetation must be provided for up to 150 feet of contributing cleared area (i.e., bare soil, non-native landscaping, lawn, and/or pasture). Slopes within the 25-foot minimum flowpath through vegetation should be no steeper than 8 percent. If this criterion cannot be met due to site constraints, the 25-foot flowpath length must be increased 1.5 feet for each percent increase in slope above 8%.
- No erosion or flooding of downstream properties may result.
- Runoff discharge toward landslide hazard areas must be evaluated by a geotechnical engineer or a qualified geologist. The discharge point may not be placed on or above slopes greater than 20% or above erosion hazard areas without evaluation by a geotechnical engineer or qualified geologist and approval by the Local Plan Approval Authority.
- For sites with septic systems, the discharge point must be downgradient of the drainfield primary and reserve areas. This requirement may be waived by the Local Plan Approval Authority if site topography clearly prohibits flows from intersecting the drainfield.

Flow Credits

- Where BMPT5.12 is used to disperse runoff into an undisturbed native landscape area or an area that meets BMP T5.13, the impervious area may be modeled as landscaped area. This is done in the WWHM by entering the impervious area into the" landscaped area" field.

BMP T5.13 Post-Construction Soil Quality and Depth

Purpose and Definition

Naturally occurring (undisturbed) soil and vegetation provide important stormwater functions including: water infiltration; nutrient, sediment, and pollutant adsorption; sediment and pollutant biofiltration; water interflow storage and transmission; and pollutant decomposition. These functions are largely lost when development strips away native soil and vegetation and replaces it with minimal topsoil and sod. Not only are these important stormwater functions lost, but such landscapes themselves become pollution- generating pervious surfaces due to increased use of pesticides, fertilizers and other landscaping and household/industrial chemicals, the concentration of pet wastes, and pollutants that accompany roadside litter.

Establishing soil quality and depth regains greater stormwater functions in the post development landscape, provides increased treatment of pollutants and sediments that result from development and habitation, and minimizes the need for some landscaping chemicals, thus reducing pollution through prevention.

Applications and Limitations

Establishing a minimum soil quality and depth is not the same as preservation of naturally occurring soil and vegetation. ~~It also does not maximize the stormwater functions that could be attained through greater soil depth and more specialized formulations as presented in BMP T5.35, Engineered Soil/Landscape Systems.~~ However, establishing a minimum soil quality and depth will provide improved on-site management of stormwater flow and water quality.

Soil organic matter can be attained through numerous materials such as compost, composted woody material, biosolids, and forest product residuals. It is important that the materials used to meet the soil quality and depth BMP be appropriate and beneficial to the plant cover to be established. Likewise, it is important that imported topsoils improve soil conditions and do not have an excessive percent of clay fines.

Design Guidelines

- Soil retention. The duff layer and native topsoil should be retained in an undisturbed state to the maximum extent practicable. In any areas requiring grading remove and stockpile the duff layer and topsoil on site in a designated, controlled area, not adjacent to public resources and critical areas, to be reapplied to other portions of the site where feasible.
- Soil quality. All areas subject to clearing and grading that have not been covered by impervious surface, incorporated into a drainage facility or engineered as structural fill or slope shall, at project completion, demonstrate the following:

~~1.Retention or enhancement of the moisture infiltration rate and soil moisture holding capacity of the original undisturbed soil native to the site. Areas which have been compacted or have removed some or all of the duff layer or underlying top soil shall be amended to mitigate for lost moisture infiltration and moisture holding capacity; and~~

~~2.~~1. A topsoil layer with a minimum organic matter content of ten percent dry weight in planting beds, and 5% organic matter content in turf areas, and a pH from 6.0 to 8.0 or matching the pH of the original undisturbed soil. The topsoil layer shall have a minimum depth of eight inches except where tree roots limit the depth of incorporation of amendments needed to meet the criteria. Subsoils below the topsoil layer should be scarified at least 4 inches with some incorporation of the upper material to avoid stratified layers, where feasible.

2. Planting beds must be mulched with 2 inches of organic material

3. Quality of compost and other materials used to meet the organic content requirements:

   a. The organic content for "pre-approved" amendment rates can be met only using Grade A Compost as defined by Department of Ecology Interim Compost Quality Guidelines (or the definition for "composted materials" in Chapter 173-350 WAC).

      The compost must also have an organic matter content of 35% to 65%, and a carbon to nitrogen ratio below 25:1.

      The carbon to nitrogen ratio may be as high as 35:1 for plantings composed entirely of plants native to the Puget Sound Lowlands region.

   b. Calculated amendment rates may be met through use of composted materials as defined above; or other organic materials amended to meet the carbon to nitrogen ratio requirements, and meeting the contaminant standards of Grade A Compost.

- ~~These criteria can be met by using on-site native topsoil, incorporating amendments into on-site soil, or importing blended topsoil. If blended topsoil is imported, then fines should be limited to twenty-five percent passing through a 200 sieve.~~
- The resulting soil should be conducive to the type of vegetation to be established.

- Implementation Options: The soil quality design guidelines listed above can be met by using one of the methods listed below

  1. Leave undisturbed native vegetation and soil, and protect from compaction during construction
  2. Amend existing site topsoil or subsoil either at default "pre-approved" rates, or at custom calculated rates based on specifiers tests of the soil and amendment
  3. Stockpile existing topsoil during grading, and replace it prior to planting. Stockpiled topsoil must also be amended if needed to meet the organic matter or depth requirements, either at a default "pre-approved" rate or at a custom calculated rate.
  4. Import topsoil mix of sufficient organic content and depth to meet the requirements.

  More than one method may be used on different portions of the same site. Soil that already meets the depth and organic matter quality standards, and is not compacted, does not need to be amended.

Planning/Permitting/Inspection/Verification Guidelines & Procedures

- Local governments are encouraged to adopt guidelines and procedures similar to those recommended in Guidelines and Resources For Implementing Soil Depth and Quality BMP T5.13 in WDOE Western Washington Stormwater Manual.

Maintenance

- Soil quality and depth should be established toward the end of construction and once established, should be protected from compaction, such as from large machinery use, and from erosion.
- Soil should be planted and mulched after installation.
- Plant debris or its equivalent should be left on the soil surface to replenish organic matter.
- It should be possible to reduce use of irrigation, fertilizers, herbicides and pesticides. These activities should be adjusted where possible, rather than continuing to implement formerly established practices.

5.3.3 Other Practices

The BMPs described in this section are other general practices for on-site treatment of stormwater.

BMP T5.30 Full Dispersion

Purpose and Definition

This BMP allows for "fully dispersing" runoff from impervious surfaces and cleared areas of development sites that protect at least 65% of the site (or a threshold discharge area on the site) in a forest or native condition.

Applications and Limitations

- Rural single family residential developments should use these dispersion BMPs wherever possible to minimize effective impervious surface to less than 10% of the development site.

- Other types of development that retain 65% of the site (or a threshold discharge area on the site) in a forested or native condition may also use these BMPs to avoid triggering the flow control facility requirement.

- The preserved area should be situated to minimize the clearing of existing forest cover, to maximize the preservation of wetlands (though the wetland area and any streams and lakes do not count toward the 65% forest or native condition area), and to buffer stream corridors.
- The preserved area should be placed in a separate tract or protected through recorded easements for individual lots.
- The preserved area should be shown on all property maps and should be clearly marked during clearing and construction on the site.
- All trees within the preserved area at the time of permit application shall be retained, aside from approved timber harvest activities and the removal of dangerous or diseased trees.
- The preserved area may be used for passive recreation and related facilities, including pedestrian and bicycle trails, nature viewing areas, fishing and camping areas, and other similar activities that do not require permanent structures, provided that cleared areas and areas of compacted soil associated with these areas and facilities do not exceed eight percent of the preserved area.

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steep slopes or existing downstream drainage problems), dispersion of roadway runoff may not be allowed, or other measures may be required.

- **Cleared Area Dispersion BMPs**

  The runoff from cleared areas that are comprised of bare soil, non-native landscaping, lawn, and/or pasture is considered to be "fully dispersed" if it is dispersed through at least 25 feet of native vegetation in accordance with the following criteria:

  1. The contributing flowpath of cleared area being dispersed must be no more than 150 feet, AND
  2. Slopes within the 25-foot minimum flowpath through native vegetation should be no steeper than 8%. If this criterion can not be met due to site constraints, the 25-foot flowpath length must be increased 1.5 feet for each percent increase in slope above 8%.

Note: Ecology proposes to delete the rest of section 5.3.3 and move BMP T5.30 into section 5.3.2. Guidance for the BMP's in section 5.3.3 is now available in Low Impact Development Technical Guidance Manual for Puget Sound, authored by the Washington State University Cooperative Extension and published by the Puget Sound Water Quality Action Team. The document is available at the following websites:

http://www.psat.wa.gov/Publications/Publications.htm

http://www.pierce.wsu.edu